Human factors: the real issues of autonomous vehicles?

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AUTHORS VERSION

Abstract
10 September 2019. Far from the technological aspect behind the autonomous vehicle and even though they are far from being solved, a gulf is being dig between human & machine in the supervision of driving.
Through this paper, the aim is to interrogate our relationship to the machine, the sharing of responsibility and ethics through the world as well as is evolution.
Author Keywords
autonomous vehicle, level of automation, SAE, perception, decision, machine learning, reactive behavior, reliability, sounding, population trust, reductionist approach, Bio- CPS
Introduction
Nowadays, a lot of research projects led by industrial stakeholders, scientists and/or engineering compagnies deal with the autonomous vehicle concept and try to figure out what are the next steps towards a full autonomous vehicle.

In order to have more and more autonomous vehicle, the Society of Automotive Engineers (SAE) proposed 6 levels of automation to classify vehicles depending on the autonomous capacities.
Even if this proposal is not the only existing model (Donge's model bring some interesting points of view as well [1]), it exposes a clear overview of the next steps of vehicle automation.
Carefully analyzing the different levels, a strong gap is emerging between levels 2 and 3 (Figure SAE). When levels 2 and below are mainly consisting in providing ADAS, based on automatic controlled regulation devices, to a human driver, level 3 and above are implying a sharing in decision for the control of the vehicle.
Indeed, after level 3, the human driver is not the unique entity aimed at making decision for the driving task. This paradigm shift leads to new issues related to the collaboration between Human and AI based decision processes. This gap is a sliding process for the human responsibility regarding the vehicle, moving from driver to system manager.

The purpose of this paper is then to expose the important scientific issues tied to this human - machine shared decision. This involves questioning on ethical concerns, AI acceptability and explainability levels and has got some important repercussions on the way one needs to design and develop artificial systems.

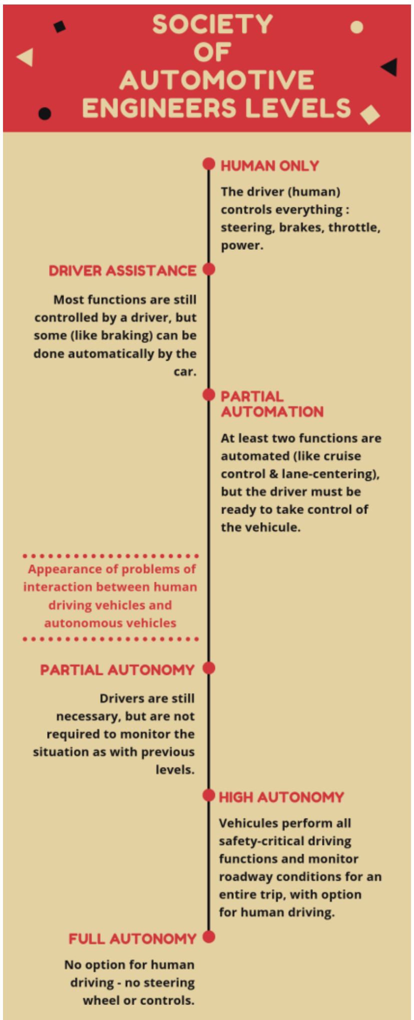

Figure 1: SAE

From technical to human factor issues

The purpose of this paper is not to fix the responsibility of the human as solely lock to the widespread of autonomous vehicle. At this time, all the purely technical issues are far from being solved.
The industrial roadmap predicts the arrival of level 5 autonomous vehicle not before 2030-2040.
A lot of technical issues, especially related to the perception or the decision process based whether on machine learning approaches [2] or reactive behavior [3] are not proved to be reliable in all the cases. Even if, some research works are made to make the algorithms more reliable [4] and to prove formally the reliability of the systems [5], the path is still long. Recent autonomous car crashes involving car prototypes as well as commercial cars with advanced ADAS are perfect examples of the need for technical improvements. In addition, those car crashes, not only raised up the limits of the current technology but also bring the following question: Are we prepared to accept that autonomous vehicle, and by extension AI based artificial device, could make some

mistakes with dramatic consequences? Analyzing the facts and the conditions behind these accidents, it is not sure that a human driver could avoid the crash. This philosophical question leads naturally to machine ethics concerns.

Machine ethics and cultural dependent AI design.

Autonomous vehicle is definitely a good example for designing blow minding example questioning the ethics a machine must/can have. An international study performed in several areas of the globe, demonstrated that the decision a human is making in a hypothetical car crash situation is tied to his/her cultural or geographical background. Thus, the understanding of an autonomous vehicle behavior and by transitivity of the embedded AI depend strongly on the cultural background of the observer. This implies a hard constraint on the way AI algorithms are developed since the design must include human factors not only in a classical way applying ergonomic and HMI principles but also including cultural background of the potential users.

AI Explainability for a better acceptability?

The acceptability is a critical point for autonomous vehicle commercial spreading especially for SAE levels 3 and 4. A recent poll, made by opinionWay in 2017 [6], reveals that 56% of the French population is not ready to step to an autonomous car for different reasons (54% fear the concept, 59% consider that the vehicle cannot make the correct decision while facing a situation…). Similar polls in the USA are revealing similar results [7]. By contrast, each day 240000 people are taking the autonomous metro line 14 in Paris without any fear. Thus, there is a deep need in explaining the way the AI systems are behaving. This is particularly crucial because an autonomous vehicle is a complex artificial system which is evolving in a complex environment.
By contrast, a metro line is quite easy to understand due to its simplicity (1D problem implying only speed regulation). This lack of understandability (and by extension acceptability) is not only linked to autonomous vehicle but can be extended to all complex artificial systems that must interact with human. Thus, there is a strong need in developing new AI and artificial systems design methods particularly in critical contexts.

Complex vs. Complicated system

A complex system is composed of a set of a huge number of entities in interaction with each other. The global behavior of such system cannot be predicted by calculations or by an external observer. Thus, a system is said as complex if the global emergent result can only be determined by experiments and simulations. In this case, a total knowledge of all systems components and of their behaviors is not enough. The existence of such systems challenges the reductionist approach [8] which considers that the complex nature of systems can be reduced to a sum or a composition of fundamental principles. If reductionism works well on complicated systems, the complex nature of some of them implies the development of integrative design approaches.

Towards human centered integrative design

The complexity of the artificial systems devoted to autonomous vehicles and the complex nature of human beings requires the development of new design approaches. In [9] & [10], we can find Bio-CPS principles that can be applied to Human Vehicle interactions and mutual understanding. Thus, AI explainability is, in this case, not only a matter of adding an additional level to already existing AI methods to make them understandable by Humans but also to rethink the way AI are designed so as to include explainability as first ranked element. This is one of the most challenging steps in developing explainable AI.

Conclusion

The prediction of an accident by an AI system of an autonomous vehicle is based on a calculation based on data from physical measurements, their processing and their statistical and probabilistic analysis. Current traffic accidents result from the interaction between technical factors and human factors such as human error, cognitive bias or loss of risk and situational awareness that are not only related to a miscalculation. or reasoning. Thus the understanding of human factors and their integration with technical factors and their design must be the conditions for the acceptability of AI driving autonomous vehicles.

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